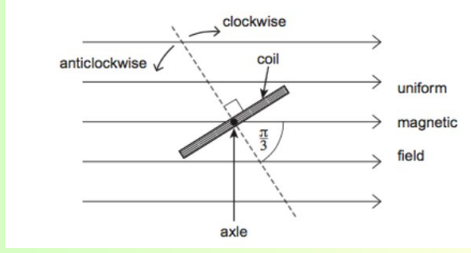
Magnetic fields	**Faraday's Law and Lenz's Law**

Learning objectives	**MUST (C)**	State Faraday's law and Lenz's law
	SHOULD (B)	Explain the relationship between emf and magnetic flux linkage, and apply this in calculations
	COULD (A/A*)	Explain how magnetic flux can be investigated using search coils

STARTER: Without looking at your notes, write down a definition/units for:

- magnetic flux density
- magnetic flux
- magnetic flux linkage



EXTENSION: Look at the diagram for the coil in a uniform magnetic field. How would you rotate it to get a) the maximum flux and b) the minimum flux?

Quantity/symbol	Definition	Unit
Magnetic flux density, B	The strength of a magnetic field, defined by B = F/IL	T
Magnetic flux, Φ	The product of the component of the magnetic flux density perpendicular to a given area and that cross-sectional area	Wb
Magnetic flux linkage	The product of the magnetic flux and the number of turns in a coil	Wb (or Wb turns)

Magnetic fields	**Faraday's Law and Lenz's Law**
MUST (C)	State Faraday's Law and Lenz's Law

The two laws that we will be applying this lesson are:

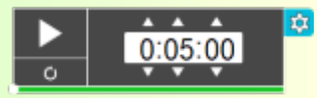
Faraday's Law: The magnitude of the induced emf is directly proportional to the rate of change of magnetic flux linkage

$$\varepsilon \propto \frac{\Delta(N\phi)}{\Delta t}$$

ε is induced emf

Δ(Nϕ) is the change in magnetic flux linkage

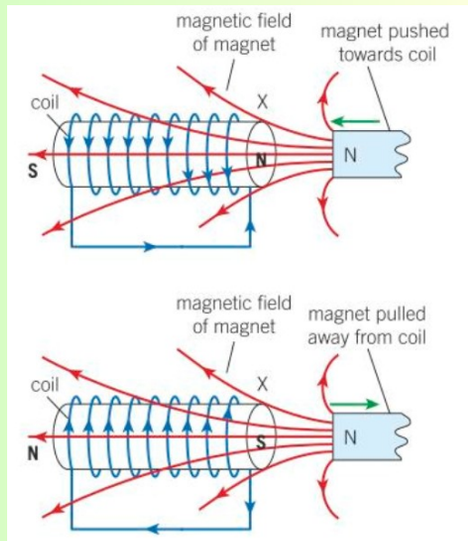
Δt is time interval



When we use Faraday's Law, the constant of proportionality is -1 and so:

$$\varepsilon = -\frac{\Delta(N\phi)}{\Delta t}$$

Lenz's Law: The direction of the induced emf or current is always such as to oppose the change producing it



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Magnetic fields	**Faraday's Law and Lenz's Law**
SHOULD (B)	Explain the relationship between emf and magnetic flux linkage, and apply this in calculations
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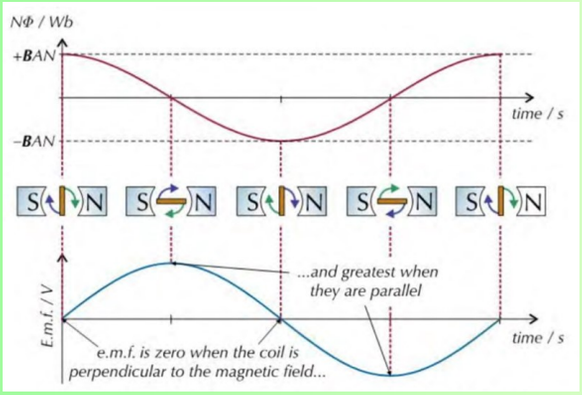
Look at the graphs for a coil rotating in a magnetic field. In which orientation is the *rate of change* of magnetic flux linkage greatest? How do you know?

In which orientation is the rate of change of magnetic flux linkage zero?



Referring specifically to Faraday's Law, write an explanation of where the emf is greatest and zero.

How can you mathematically link the graphs?

emf is -(gradient of flux linkage graph at that point)

Search coils

Search coils are flat coils of insulated wire connected to a galvanometer.

To calibrate them, they are placed in a known magnetic field (calibration field) and quickly withdrawn. The induced current is measured.

The search coil can then be placed in another magnetic field and quickly withdrawn: the induced current is directly proportional to the rate of change of flux linkage, so if (for example) the current was double, the magnetic flux of the new field would be double the flux of the calibration field.

Activities

Summarise the search coil details in a flow map, to show how the process works.

Try the practice questions 3-5 for section 23.5

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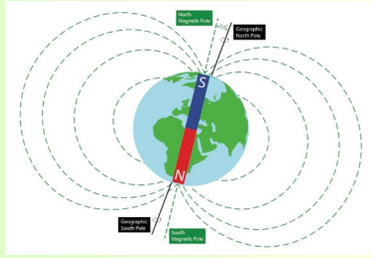
PLENARY: Why might you expect an aeroplane to have a potential difference across its wings?

Extension: Would this be the same wherever it flew on Earth? Use the diagram to help.



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